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Localised impacts of national low carbon energy scenarios

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Introduction

The UK Government has a legally binding target to reduce greenhouse gas (GHG) emissions by 80% by 2050, compared to 1990 levels. Scenarios achieving the 80% target involve significant electrification of the heat, transport and industry sectors along side decarbonisation of the electricity sector. Therefore, the growth in demand for electricity is predicted to be significant over the next 40 years.

Growth in demand may not be universally distributed throughout the whole of the UK however. Hence there is a need to understand the potential impact on local distribution networks in order to plan for a future low carbon electricity system.

Method

The project focused on domestic electrical load.

- Create 2011 seasonal load profile for the north east
- Determine scaling factor for UK-north east 2011
- Find 2050 mean UK electricity annual consumption for households using the 2050 pathways calculator (DECC, 2012)
- Apply scaling factor to UK 2050 to create north east 2050 seasonal profiles
- Use demand profile in simple distribution network model to identify network issues

Results

National level scenarios are often used to generated local energy strategies. These high-level plans outline the technologies that might be used on a pathway to a low-carbon future, as shown in Figure 1.

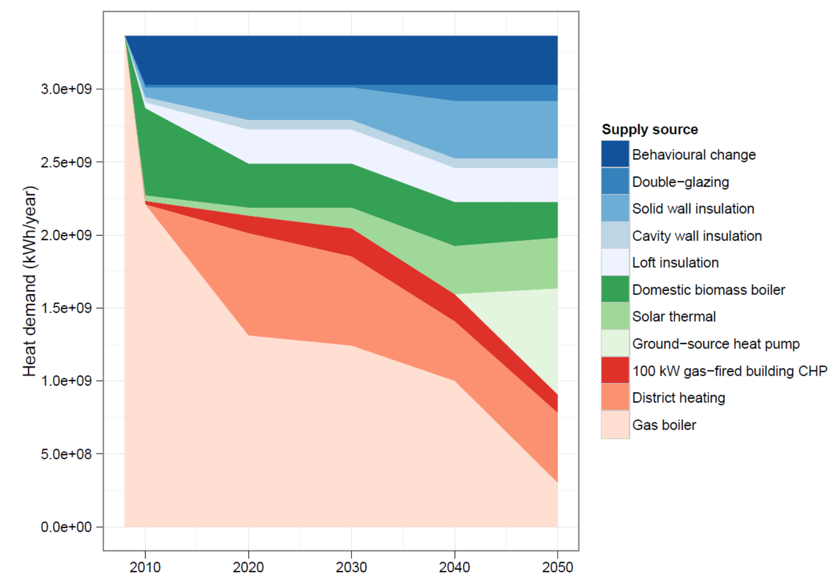

Figure 1. Heat generation strategy for Newcastle to 2050 (Keirstead and Calderon, 203).

However these results require a more detailed investigation to understand impacts on individual buildings or network assets. For example, the generated regional load profiles for six 2050 scenarios were used as input to a simple distribution network model, for a piece of network in Cramlington, north east UK. The model identified transformer load, voltage levels and current levels over a 24 hour period, for a summer and winter load profile. For example, Figure 2 shows summer transformer load for the gamma scenario, with significant reverse power flow through the transformer during daylight hours.

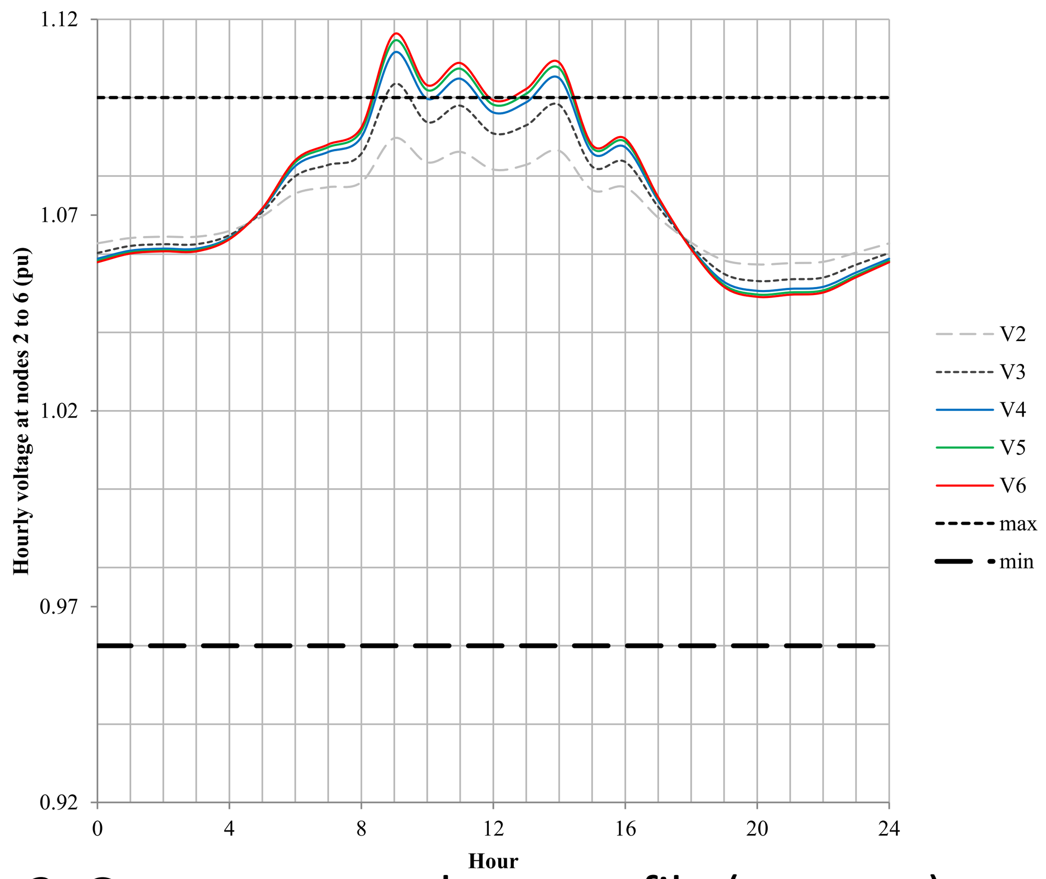

Figure 2. Gamma case voltage profile (summer)

Modelling demonstrated that the gamma scenario led to the most network issues, and the delta scenario the least issues. All but the zeta scenario require significant load reduction.

Conclusions

Given the target to transition to a low carbon pathway, and the evidence that the existing distribution system is not capable of accommodating power flows in future local low carbon scenarios, there is a window of opportunity during which re-engineering of our energy system can be considered.

This needs a holistic view of what is possible in the domestic sector and in electricity distribution networks.

1. Local 2050 pathways assume significant demand reduction in the domestic sector

   How can we achieve that efficiently in terms of money and time?

2. Local 2050 pathways lead to issues for local distribution networks

   Can "smart grids" mitigate the issues?

   What operational and business model pressures come along side the technical network pressures?

3. Local 2050 pathways have been derived from national scenarios

   How can we develop truly local scenarios and enable local governance and ownership of energy issues?

Further information

Keirstead, J., & Calderon, C. (2012). "Capturing spatial effects, technology interactions, and uncertainty in urban energy and carbon models: Retrofitting Newcastle as a case-study." Energy Policy, 46, 253–267. doi:10.1016/j.enpol.2012.03.058.

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